AvA-101 (PC)

JP Laid-Open Gazette No. 2000-83057 as published on March 21, 2000 (JP Application No. H10-252174 as filed on September 7, 1998)

(54) [Title of the Invention]

Network management terminal apparatus and path information collection method

(57) [Abstract]

[Problem to be Solved]

A single management terminal efficiently checks based on path information exchanged between each node through a path control protocol, the path of a packet flowing in a network.

[Solution]

A management terminal 1 collects from node R1, path information of area 1 and node information for specifying other nodes R2 and R3, which are retained in R1, and stores these pieces of information, and collects from R2 specified based on the stored node information, path information of area 2 retained in R2 and stores the path information, and collects from the remaining node, R3, path information of area 3 retained in R3 and stores the path information, and determines based on the stored node information, a path via which a packet is to be transferred from one node to another node.

[Claims for the Patent]

[Claim 1]

A network management terminal apparatus characterized by comprising: collection means for collecting from a node in a network, path information and node information for specifying other nodes, which are retained in the node; storage means for storing the path information collected by the collection means; collection control means for causing, based on the information for specifying the other nodes collected by the collection means, the collection means to collect path information and node information from the other nodes; and path calculation means for determining, based on the path information stored in the storage means, a path via which a packet is to be transferred from one node to another node.

[Claim 2]

The network management terminal apparatus according to claim 1, characterized in that the collection means collects as the path information, information containing connection information between nodes in an area of a layer to which the node belongs, and as the node information, collects information for specifying a boundary router lying in a boundary between the layer to which the node belongs and another layer; and the collection control means causes the collection means to collect from the boundary router, path information containing connection information between nodes in an area of said another layer.

[Claim 3]

The network management terminal apparatus according to claim 1, characterized in that the collection means collects as the

path information, path information received by the node from an adjacent node, and as the node information, information for specifying an adjacent node of the node; and the collection control means causes the collection means to collect from the adjacent node, path information received by the adjacent node from an adjacent node.

[Claim 4]

The network management terminal apparatus according to claim 1, characterized in that when the collection means collects as the path information, information containing information exchanged through one path control protocol and information containing path table information preliminarily set in the node, and when, if a packet path calculated based on the information exchanged through the path control protocol is different from a packet path determined based on the preliminarily set path table information, the path calculation means selects any of the paths based on a priority order used for the node to determine a path.

[Claim 5]

The network management terminal apparatus according to claim 1, characterized in that when the collection means collects as the path information, information containing information exchanged through one path control protocol and information containing information exchanged through another path control protocol, and when, if a packet path calculated based on the information exchanged through the one path control protocol is different from a packet path calculated based on information exchanged through said another path control protocol, the path

calculation means selects any of the paths based on a priority order used for the node to determine a path.

[Claim 6]

The network management terminal apparatus according to claim 1, characterized by further comprising display means for displaying a packet path determined by the path calculation means and topology of the network determined based on the path information stored in the storage means.

[Claim 7]

A path information collection method characterized by collecting from a first node specified in a network, path information and node information for specifying other nodes, which are retained in the first node, and storing these pieces of information and then collecting from one of the other nodes indicated by the stored node information, path information and node information, which are retained in the node, and storing these pieces of information, and repeating the above operation, until there is not left among the nodes indicated by the stored node information, any node which is to be accessed for path information collection but has not yet been accessed.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a management terminal that manages a node included in a network.

[0002]

[Conventional Art]

In the Internet, multiple routers/hosts (collectively referred to as a node) are connected to transfer data. In sending some data, destination information (for example, IP address) is attached to the data to send it to a router. The router transfers based on a path table retained in the router, the data to a next router toward the destination. This operation is sequentially carried out by each router lying on the path, whereby the data reaches a host being the destination. The path tables lying in these routers are not controlled by a central management terminal, but produced when each router exchanges a control message (path control protocol).

[0003]

In order to detect a failure of the network which operates in such a distributed manner, each node must be checked. To reduce the labor of the network administrator, there has been a system in which a single management terminal can monitor the state of each node. For example, the management terminal can check through SNMP (Simple Network Management Protocol) or the like, the type of each node, whether or not each node is active, and whether or not each interface is active when the nodes have multiple interfaces.

[0004]

[Problems to be Solved by the Invention]

In checking the operation of the Internet, it is preferable that a management terminal can check the operation of nodes and the operation of links between nodes all at once. Whether or not the nodes are active and whether or not the node interfaces are active, can be monitored when a monitoring packet is

periodically sent and received between the management terminal and the nodes to be managed.

[0005]

In this case, although it can be checked that the router is currently active and that the packet reachability from the management terminal to the router is currently ensured, it is not possible to check whether or not the router is in a state of being capable of transferring a packet normally, i.e., whether or not the path table retained in the router is correct.

[0006]

Thus, the present invention has an object to provide a mechanism by which a single management terminal can efficiently check based on path information exchanged between each node through a path control protocol, the path of a packet flowing in a network.

[0007]

[Means for Solving the Problems]

A network management terminal apparatus according to the present invention is characterized by including: collection means for collecting from a node in a network, path information and node information for specifying other nodes, which are retained in the node; storage means for storing the path information collected by the collection means; collection control means for causing, based on the information for specifying the other nodes collected by the collection means, the collection means to collect path information and node information from the other nodes; path calculation means for determining, based on the path information stored in the storage

means, a path via which a packet is to be transferred from one node to another node.

[0008]

When path information and the like retained in the node are information contained in a link state type path control protocol exchanged by the node, it is preferable that: the collection means collects as the path information, information containing connection information between nodes in an area of a layer to which the node belongs, and as the node information, collects information for specifying a boundary router lying in a boundary between the layer to which the node belongs and another layer; and the collection control means causes the collection means to collect from the boundary router, path information containing connection information between nodes in an area of said another layer.

[0009]

When path information and the like retained in the node are information contained in a distance vector type path control protocol exchanged by the node, it is preferable that: the collection means collects as the path information, path information received by the node from an adjacent node, and as the node information, information for specifying an adjacent node of the node; and the collection control means causes the collection means to collect from the adjacent node, path information received by the adjacent node from an adjacent node.

[0010]

Also, when the collection means collects as the path information, information containing information exchanged

through one path control protocol and information containing path table information preliminarily set in the node, and when, if a packet path calculated based on the information exchanged through the path control protocol is different from a packet path determined based on the preliminarily set path table information, the path calculation means
selects any of the paths based on a priority order used for the node to determine a path, even when a network is to be managed in which each node selects based on self-determination, any of a dynamically determined path and a statically determined path, the management terminal can determine the same path as that determined by each node.

[0011]

Also, when the collection means collects as the path information, information containing information exchanged through one path control protocol and information containing information exchanged through another path control protocol, and when, if a packet path calculated based on the information exchanged through the one path control protocol is different from a packet path calculated based on information exchanged through said another path control protocol, the path calculation means selects any of the paths based on a priority order used for the node to determine a path, even when a network is to be managed in which a plurality of path control protocols are active, the management terminal can determine the same path as that determined by each node.

[0012]

There may be further included display means for displaying a packet path determined by the path calculation means and topology of the network determined based on the path information stored in the storage means.

[0013]

A path information collection method according to the present invention is characterized by collecting from a first node specified in a network, path information and node information for specifying other nodes, which are retained in the first node, and storing these pieces of information and then collecting from one of the other nodes indicated by the stored node information, path information and node information, which are retained in the node, and storing these pieces of information, and repeating the above operation until there is not left among the nodes indicated by the stored node information, any node which is to be accessed for path information collection but has not yet been accessed.

[0014]

[Embodiments of the Invention]

The present invention will be described below with reference to the drawings illustrating an embodiment thereof. As path control protocols for the Internet, there are two types: link state type and distance vector type.

[0015]

First, as illustrative example 1, there will be described a method by which, when a network to be checked uses a link state type path control protocol, a management terminal collects path information retained in each node and determines based on the

collected path information, each packet path in the network to be checked. Here, description will be given by taking as an example, OSPF (Open Shortest Path First) being the link state type path control protocol used in the Internet, but the similar operation can be performed with another link state type protocol.
[0016]

OSPF is a hierarchic ink state type path control protocol. A node which belongs to a layer has all the link state information of the layer. Link state information indicates nodes at both ends of each link and the cost of the links. When acquiring all the link state information retained in a node from a node, a management terminal according to the present embodiment perceives nodes at both ends of each link, and thus can determine network topology of the layer. Also, the management terminal can determine a packet path by calculating a shortest path based on the determined topology and the cost of each link indicated by the link state information.
[0017]

When the number of layers is one, the topology of the whole network to be checked and path information calculated through the path control protocol can be acquired by acquiring all the link state information from one node.
[0018]

When there are multiple layers, all the link state information is acquired from a node belonging to one layer and at the same time, information retained in a node via which the layer is connected to another layer is acquired. And all the link state information is acquired from the node for connection

to another layer. Further, when there are other layers, the similar operation is repeated, so that the path information of all the layers can be acquired.

[0019]

This link state information acquiring method will be described in detail by taking as an example, a network illustrated in Figure 1. An exemplary link state acquiring procedure is illustrated in Figure 2; and an example of management table retained in a management terminal is illustrated in Figure 3.

[0020]

A management terminal (1) acquires link state information and information on layer boundary router from a first target node in a network to be managed. First, the first target node is selected (S100 in Figure 2). In this example, R1 (11) is selected as the first node. In selecting the first target node, the network administrator may preliminarily set identification information (address) of a first node to be accessed for information collection and then check this setting to perform the selection, or the management terminal may automatically check identification information (address) of a default router of the network to which the management terminal belongs, and select the default router as the first node.

[0021]

Then, the management terminal transmits an inquiry packet to R1 and receives a response packet to acquire a network area number to which R1 belongs (S101 in Figure 2). In this example, R1 belongs only to area 1; thus R1 returns an answer that R1

belongs to area 1. Since the target node R1 is not a boundary node, the management terminal does not store that router in the boundary router table (S102 in Figure 2).

[0022]

Subsequently, the following procedure is executed for all the areas which have been accessed for information acquisition. Since R1 belongs only to area 1, the execution is carried out only for area 1. It is checked whether or not area 1 has already been stored in an area table (S103 in Figure 2). Since R1 is a first node, there has been no description in the area table; this area has not been stored in the area table ("NO" in S103 of Figure 2). Thus, the management terminal transmits an inquiry packet to R1 being a target node, and receives a response packet to acquire link state information and boundary router information (S104 in Figure 2). The link state information contains information on connection from R1 (11) to R2 (12), from R2 (12) to R1 (11), from R1 (11) to R3 (13), from R3 (13) to R1 (11), from R2 (12) to R3 (13), from R3 (13) to R2 (12), and the cost of these links (being set to 1, 1, 2, 2, 4 and 3). Since area 1 includes boundary routers R2 and R3, identification information (address) of R2 and R3 is acquired.

[0023]

The acquired link state information is as illustrated in Figure 3 (b), stored as a link state table. Also, the area number of area 1 and a pointer to the link state table of Figure 3 (b) are written into the area table (being empty at this time) of Figure 3 (a) (S105 in Figure 2). And boundary router addresses R2 and R3 are written into the boundary router table

of Figure 3 (e). At this time, nothing is written in a column (area number) indicating an area number to which the boundary router belongs and in a column ("acquired") indicating that link state information has already been acquired.

[0024]

In this way, information on all the areas to which the target node R1 belongs has been acquired, so the following procedure is executed. A check is carried out on the boundary routers which, the boundary router table indicates, have not yet been accessed for information acquisition (S106 in Figure 2). In this case, R2 and R3 are currently stored as "not acquired", so R2 is set as a target node, and information (yes) indicating "acquired" is written in the column titled "acquired" of entry R2 of the boundary router table (S107 in Figure 2).

[0025]

Then, a procedure similar to the above described one is executed with R2 set as a target node. That is, when the area number of R2 is acquired, it is found that R2 belongs to area 1 and area 2 (S101). The area number is stored in the boundary router table (S102). Subsequently, steps S103 to S105 are executed for each area to which R2 belongs. Area 1 has already been stored in the area table, so nothing is executed ("Yes" in S103). Since area 2 has not been stored in the area table, link state information and boundary router information on area 2 are acquired from R2 (S104). The link state information is added as a link state table of Figure 3 (c); and an entry containing the area number of area 2 and a pointer to the link state table is added to the area table of Figure 3 (a); and since there is no

boundary router, nothing is stored in the boundary router table (S105).

[0026]

Subsequently, a procedure similar to the above described one is executed for R3 which, the boundary router table indicates, has not yet been accessed for information acquisition (S101 to S105). When the procedure is completed for R3, there is left no router in the boundary router table which has not been accessed for information acquisition, so the processing is finished ("No" in S106).

[0027]

After the above described operation, the area table, link state table and boundary router table change to the state illustrated in Figures 3 (a) to 3 (e). An exemplary configuration of the management terminal which performs the above described operation is illustrated in Figure 4. Collection means (401) of Figure 4 performs communication for collecting required information from a router being a target. For example, when information is acquired through SNMP, SNMP packets are transmitted/received to collect the above described information.

[0028]

Boundary router storage means (403) stores the boundary router table of Figure 3. Path information storage means (404) stores the link state table and area table of Figure 3. Collection control means (402) causes the collection means (402) to collect information according to the procedure illustrated in Figure 2, and then causes each of the storage means to appropriately store information.

[0029]

When the above described procedure is executed by the management terminal, of some pieces of information which have been exchanged between the nodes through the path control protocol, required information is collected by the management terminal, so that the management terminal can calculate a path from a transmitting node to a destination node based on the collected information (information stored in the path information storage means). According to conventional art, in order to check a path from a transmitting node to a destination node, there must be executed a procedure by which a packet is actually transmitted from the transmitting node to the destination node, and each router on the path transfers this packet while writing information into this packet, and its response (in which the path of the transferred packet is written) is sent back to the transmitting node. This procedure must be executed for each path to be checked. According to the present embodiment, however, a single management terminal can check any path from a transmitting node to a destination node, thus reducing the labor of the network administrator.

[0030]

Also, using the information collected by the management terminal according to the present embodiment, the management terminal can simulate, without using the network actually operated, a change in path when link cost is changed, or simulate path modification when a trouble occurs in the link.

[0031]

According to the collection method of the present embodiment, the inquiry is not carried out from a single management terminal to all the routers in the network, but minimum necessary routers are selected to acquire path information. Thus, it is sufficient to transfer minimum management information data.

[0032]

As illustrative example 2, there will be described a method by which, when a network to be checked uses a distance vector type path control protocol, a management terminal collects path information retained in each node and determines based on the collected path information, each packet path in the network to be checked.

[0033]

When a distance vector type path control protocol is used, path information must be collected from all nodes in a network to be checked. Here, description will be given by taking as an example, a case where BGP (Border Gateway Protocol) being a distance vector type path control protocol is used, but the similar operation can be performed with another distance vector type path control protocol.

[0034]

With BGP, the administrator preliminarily sets the address of an adjacent router in a router. BGP message is exchanged between the router and the adjacent router. In a BGP message, there are written a destination network or a destination host, and a cost needed to reach the destination, these pieces of information being necessary to produce a path table. An access

path indicating which path will be to taken to reach the destination, and other information are also written.

[0035]

A router receives a BGP message from an adjacent router and determines based on the received message, an adjacent router used to reach the destination. The determination of an adjacent router is usually made based on an advertisement of adjacent router saying that it costs less to reach the destination. Exceptionally, the router administrator may make a router setting so that a path is determined based on a factor other than cost. In this case, for example, data packet transfer path taken when a given adjacent router is selected is found out by perceiving the path information of BGP information received from an adjacent router; thus, when a spot to be avoided lies in the path, that adjacent router may be prevented from being used, or on the contrary, when a definitely desired spot lies in the path, that adjacent router may be used even when it costs much. In short, a path table can be produced based on the information received through BGP from an adjacent router while reflecting the administrator's policy.

[0036]

A method of the management terminal collecting BGP information will be described by taking as an example, a network illustrated in Figure 5. R1, R2 and R3 mutually exchange path information through BGP. In Figure 5, R1 and R2 have reachability to destination A; and R2 and R3 have reachability to destination B.

[0037]

First, the management terminal determines a target node to be accessed to acquire information. This may be preliminarily set, or when the default router of the management terminal is a BGP router, this default router may be determined as the target node. In this example, R1 is set as a first node.

[0038]

The management terminal acquires information on BGP from R1. In the acquired information, there are contained the address of an adjacent router of R1 and path information received from that adjacent router. The path information includes, as described above, the destination address, the cost required to reach the destination, and other pieces of information. After the information has been acquired, R1 is written into an acquisition node table of Figure 6(a), and a pointer to a path information table (Figure 6(b)) which stores path information on R1 is written. In the pointed path information table, there is written path information which R1 has received from adjacent routers R2 and R3. Referring to Figure 5, R2 has reachability to destinations A and B; destination A is reachable at cost 1, and destination B is reachable at cost 2. These pieces of information are transferred from R2 to R1 through BGP. Thus, the management terminal can acquire the above path information by making an inquiry to R1; the path information is written as illustrated in Figure 6(b). Similarly, R1 has been notified that destination B is reachable at cost 1 from the adjacent router R3, so the management terminal can also acquire this path information by making an inquiry to R1; the path information is also written as illustrated in Figure 6(b).

[0039]

Subsequently, since the management terminal can find out, based on the information acquired from R1, that the adjacent routers of R1 are R2 and R3, the management terminal writes this information into the acquisition node table of Figure 6(a). If corresponding routers have already been written in the acquisition node table, no operation is performed. Since information has not yet been acquired from R2 and R3, pointers to R2 and R3 have not been written.

[0040]

And when there is a router which has been written in the acquisition node table but has not yet had a pointer written, the management terminal acquires BGP information from that router being a target node. The information acquisition and storage are carried out similarly to the above described one. When R2 is set as a target node, a path information table of Figure 6(c) is produced, and a corresponding pointer is written.

[0041]

When the above operation is repeated, so that there is left no router to be newly written into the acquisition node table and at the same time, information collection (production of path information table and writing of pointer) from all the routers which have been written in the acquisition node table is completed, all the information collection is finished. For the network illustrated in Figure 5, the acquisition node table and path information table have contents as illustrated in Figure 6(a) to 6(d).

[0042]

In the above described procedure, path information is collected from all the BGP routers, but it is also possible that, when an address range of routers to be managed is specified in the management terminal, information collection is limited to routers in a required range.

[0043]

As the management terminal performing the above described operation, a management terminal having a configuration similar to that illustrated in Figure 4 can be used (the boundary router storage means 403 of Figure 4 may be omitted). The collection control means 402 stores information collected by the collection means 401 into the path information storage means 404 in a manner as illustrated in Figure 6.

[0044]

The management terminal can calculate based on the path information collected in this manner, a path from a transmitting node to a destination node. In a case where a router to be managed determines a path in view of factors other than cost, when BGP path information is acquired from that router and at the same time, information on path determination method (for example, when there are nodes to be avoided, or nodes to be definitely passed through, the information on path determination method is information on those nodes) is also acquired, the management terminal can determine a path identical to that written in path tables of each router.

[0045]

As illustrative example 3, there will be described a method by which, when multiple path control protocols operate in a

network to be checked, a management terminal acquires path information exchanged through these path control protocols to determine paths of each packet. Here, by way of example, there will be described a case where, while OSPF is used in part of a network, BGP is used in another part thereof (an area where OSPF is used may overlap with an area where BGP is used).

[0046]

A target node to be accessed for information collection is preliminarily registered for each path control protocol in the management terminal. For example, for OSPF, router A in which OSPF operates is specified as a first node; for BGP, router B in which BGP operates is specified as a first node.

[0047]

Then, the procedure of illustrative example 1 is executed starting with router A, and the procedure of illustrative example 2 is executed starting with router B (these procedures may be concurrently executed, or it is possible that, after the procedure for OSPF is finished, that for BGP starts). As a result, information as illustrated in Figure 3 is obtained for the area where OSPF is used, and information as illustrated in Figure 6 is obtained for the area where BGP is used. By integrating these pieces of information for the path control protocols, the management terminal can calculate a packet path from a transmitting node to a destination node in the network to be managed.

[0048]

In acquiring information for multiple path control protocols, the following method other than the above described one can also

be used. For one thing, there is used a method by which, in the management terminal, there are preliminarily registered a first target node and information on what types of path control protocols are to be used for information collection (a first target node does not need to be registered for each path control protocol to be used for information collection). In this case, first, the registered first node is accessed to collect information on one path control protocol (for example, BGP). Then, while the procedure of illustrative example 2 is executed, when a router which also corresponds to another path control protocol (protocol which has been registered to be used for information collection, for example, OSPF) emerges as a target node to be accessed for information collection, the procedure of illustrative example 1 is started with this router set as a first target node for said another path control protocol (the procedure of illustrative example 2 also proceeds independently). [0049]

For another, there is used a method by which, in the management terminal, there are preliminarily registered a path control protocol and a first target node for this protocol, and information collection on this registered path control protocol is made, and a router which exchanges information through another protocol is found out based on the collected information on the path control protocol. For example, according to OSPF described in illustrative example 1, path information acquired from a path control protocol other than OSPF can also be exchanged, and a distinction between path information on OSPF and that on the other protocol is also possible to make. Thus,

while information collection is performed as described in illustrative example 1, it can be checked whether or not a path control protocol other than OSPF is operative in the network. If so, a node in which the path control protocol other than OSPF is operative is set as a target node, and an information acquisition procedure (for example, the procedure of illustrative example 2 when the other path control protocol is BGP) of the other path control protocol is executed.

[0050]

When the multiple path control protocols are both operative in one area in the network, different paths may be selected, depending on the path control protocols, to reach the same destination. In this case, a priority order between the path control protocols is preliminarily established; a path calculated according to the path control protocol having a higher priority order is determined as the path to be written into the router path table. For example, when the priority order of BGP path control protocol is 1 and that of OSPF path control protocol is 2, the protocol having the higher priority order is selected; thus, when the paths to the identical destination are different between the multiple path control protocols, OSPF path is used.

[0051]

In order to allow the management terminal to calculate the same paths as the ones which each router has written into the path tables, the priority order of path control protocols used by each router is preliminarily set in the management terminal, or the management terminal makes an inquiry to each router to

acquire the priority order of respective path control protocols used by each router. The information on priority order may be collected along with the above described path information, or a separate message for priority order inquiry may be sent.

[0052]

The method of the management terminal collecting path information has been described above by taking as an example, a case where the path table entries of each router are dynamically produced by the path control protocols. However, in actual networks, the administrator may perform path setting manually in the routers to thereby set a static path. The static path is composed of information on a destination and a router of subsequent hop sent when a packet for the destination is received. This information must be acquired from each router which uses the static path. Thus, in the procedure by which the management terminal acquires from a router, path information exchanged through the above path control protocol, this information on static path is also collected, whereby the management terminal can also collect the information on static path.

[0053]

This can be implemented by sending back the information on static path concurrently when link state information and information on layer boundary router are sent back to the management terminal (in a case where OSPF is used), or when information on adjacent router and path information are sent back to the management terminal (in a case where BGP is used). Alternatively, the management terminal may send a message for

static path inquiry to each router, so that each router replies. In this case, information on from which router, information on static path has been received is stored so that the information is prevented from being acquired plural times from the same router, allowing prevention of useless information collection. For the identical destination, when a statically set path is different from a path dynamically selected through the path control protocol, similarly to the priority order used for path selection when the subsequent-stage router for the identical destination is different between different protocols, information on priority order for path selection between the statistically determined path and the dynamically determined path may be preliminarily set in the management terminal, or the management terminal may make an inquiry to each router to acquire the information, so that the management terminal can determine the same path as that to be used by each router.

[0054]

As illustrative example 4, there will be described a method by which, packet paths determined as described in illustrative examples 1 to 3 are visualized to be displayed on the management terminal in order for the user (for example, the network administrator) to monitor it, or path modification when a link or node fails is simulated.

[0055]

Based on the information acquired in illustrative examples 1, 2 and 3, the management terminal can collect network topology and information exchanged through each path control protocol to determine each packet path. Thus, it is possible to display

based on this information, network topology as illustrated in Figure 7 and display a path from a given node to a given node. In Figure 7, a path from R2 to R3 is displayed. Also, with a hierarchized path control protocol, when area 1 is displayed, information on the other area is not displayed, and information (shaded part in Figure 7) for indicating a boundary router is displayed in boundary routers from among nodes in area 1. When one boundary router is specified on the screen to display another area, network topology of area 2 as illustrated in Figure 7 is displayed, whereby packet paths in area 2 can be monitored.

[0056]

Such path displaying can be performed for each path control protocol which has been accessed for information collection. That is, for a network in which multiple path control protocols are operative, the respective paths selected by each protocol can be monitored.

[0057]

Meanwhile, a path is eventually determined based on a priority order between path control protocols; thus, it is also possible to display only the finally selected path based on the priority order. Further, a simulation can be performed on the management terminal by making a calculation using the collected information, in order to find out how path information changes when a pseudo failure is made to occur in a node or link. Also, a simulation can be performed to find out a path change when the link cost is increased or decreased. Since the above described tests can be performed on the management terminal, a trouble can

be readily found before an operation is actually performed on a network currently used, so that adverse effects on the operative network are reduced.

[0058]

When the acquisition methods of the illustrative examples 1, 2 and 3 are periodically executed, a history of path information can be collected in the management terminal. Accordingly, the management terminal can check when failure or topology modification has occurred. Further, in a case where a normal path is preliminarily stored in the management terminal, when a path currently used on the network (a path calculated based on the collected information at this time) is different from the registered normal path, the management terminal can warn the network administrator against abnormality.

[0059]

Each step of the above described means and collection methods of the management terminal can also be implemented by causing a commonly-used computer to read a program for the present embodiment and execute it. The present invention can also be perceived as a storage medium having stored therein the program to be read into a computer. Also, many modifications to the embodiment described above and many applications thereof are possible without departing from the gist of the invention.

[0060]

[Advantages of the Invention]

According to the present invention, information exchanged between each node through a path control protocol can be efficiently collected by a single management terminal, so that

the management terminal can calculate information indicating a path via which a packet is to be transferred, without actually transferring a packet from a node to another node, the path being identical to that written in a path table produced in each node.

[Brief Description of the Drawings]

[Figure 1]

Figure 1 is a view illustrating an exemplary network to be accessed to collect path information.

[Figure 2]

Figure 2 is a view illustrating an exemplary procedure for a management terminal collecting path information.

[Figure 3]

Figure 3 is a view illustrating an exemplary table which is stored in the management terminal at the time of collecting path information.

[Figure 4]

Figure 4 is a view illustrating an exemplary configuration of the management terminal.

[Figure 5]

Figure 5 is a view illustrating another exemplary network to be accessed to collect path information.

[Figure 6]

Figure 6 is a view illustrating another exemplary table which is stored in the management terminal at the time of collecting path information.

[Figure 7]

Figure 7 is a view illustrating an example in which network topology and packet paths determined based on the collected path information are displayed on a screen.

[Description of Symbols]

401 Collection means

402 Collection control means

403 Boundary router storage means

404 Path information storage means

Figure 1

1 MANAGEMENT TERMINAL

#1 AREA

Figure 3

#1 AREA TABLE

#2 AREA NUMBER

#3 POINTER

#4 LINK STATE TABLE (AREA 1)

#5 LINK

#6 COST

#7 BOUNDARY ROUTER TABLE

#8 ADDRESS

#9 AREA

#10 ACQUIRED

Figure 2

S100 DETERMINE FIRST TARGET NODE

S101 ACQUIRE NUMBER OF AREA TO WHICH TARGET NODE BELONGS

S102 STORE ROUTER AND NUMBER OF AREA TO WHICH THAT ROUTER BELONGS WHEN TARGET NODE IS BOUNDARY ROUTER

S103 THAT AREA HAS ALREADY BEEN WRITTEN IN AREA TABLE?

S104 ACQUIRE FROM TARGET NODE, 1.LINK STATE INFORMATION AND 2. INFORMATION ON BOUNDARY ROUTER

S105 ADD THAT AREA TO AREA TABLE

STORE LINK STATE INFORMATION IN LINK STATE TABLE

STORE BOUNDARY ROUTER IN BOUNDARY ROUTER TABLE

S106 IN BOUNDARY ROUTER TABLE, THERE IS LEFT ANY BOUNDARY ROUTER WHICH HAS NOT BEEN ACCESSED TO ACQUIRE INFORMATION?

S107 SET AS TARGET NODE, ROUTER WHICH HAS BEEN WRITTEN IN BOUNDARY ROUTER TABLE AND WHICH HAS NOT BEEN ACCESSED TO ACQUIRE INFORMATION

STORE IN BOUNDARY ROUTER TABLE, THE FACT THAT INFORMATION IS TO BE ACQUIRED AS TARGET

#1 EXECUTE THIS OPERATION FOR ALL AREAS FROM WHICH INFORMATION HAS BEEN ACQUIRED

#2 END

Figure 5

#1 DESTINATION A

#2 DESTINATION B

#3 MANAGEMENT TERMINAL

Figure 4

401 COLLECTION MEANS

402 COLLECTION CONTROL MEANS

403 BOUNDARY ROUTER STORAGE MEANS

404 PATH INFORMATION STORAGE MEANS

#1 MANAGEMENT TERMINAL

#2 NETWORK

Figure 7

#1 AREA

Figure 6

#1 ACQUISITION NODE TABLE

#2 NODE

#3 POINTER

#4 ADJACENT ROUTER

#5 DESTINATION ADDRESS

#6 COST

#7 OTHER INFORMATION

ポロジー変更がいつ行われたかチェックすることが可能になる。また、正常な経路を予め管理端末に記憶しておけば、実際にネットワークで使われている経路（そのときに収集した情報から計算される経路）が、登録された正常な経路と異なる場合は、管理端末がネットワーク管理者に対して異常通知を行うことができるようになる。

【００５９】以上に説明した管理端末の各手段や収集方法の各ステップは、一般のコンピュータに、本実施形態用のプログラムを読み込んで実行させることによっても、実現可能である。本発明は、このためにコンピュータに読み込ませるプログラムを格納した記憶媒体に係る発明としても把握される。また、上述した実施形態の他にも、本発明はその趣旨を逸脱しない範囲で、様々な変形実施や応用が可能である。

【００６０】

【発明の効果】本発明によれば、経路制御プロトコルにより各ノード間で交換された情報を、効率良く一つの管理端末上に収集することができ、各ノードに生成された経路表と同様の、パケットが転送される経路を示す情報を、実際にあるノードから別のノードへパケットを転送してみることなく、管理端末上で求めることが可能になる。

【図面の簡単な説明】

【図１】　経路情報収集の対象となるネットワークの一例を示す図。

【図２】　管理端末が行う経路情報の収集の手順の一例を示す図。

【図３】　経路情報収集時に管理端末に記憶される表の一例を示す図。

【図４】　管理端末の構成の一例を示す図。

【図５】　経路情報収集の対象となるネットワークの他の例を示す図。

【図６】　経路情報収集時に管理端末に記憶される表の他の例を示す図。

【図７】　収集された経路情報から求められるネットワークトポロジーとパケットの経路を画面上に表示した例を示す図。

【符号の説明】

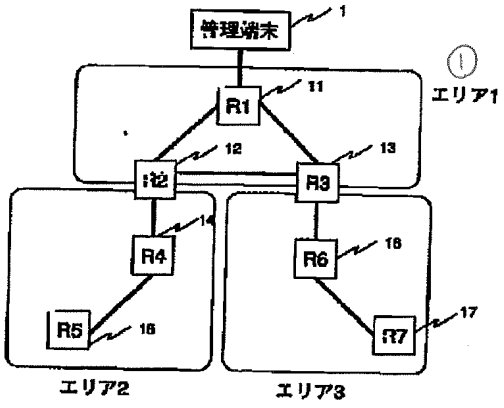
４０１…収集手段

４０２…収集制御手段

４０３…境界ルータ記憶手段

４０４…経路情報記憶手段

【図1】 Fig. 1



【図3】 Fig. 3

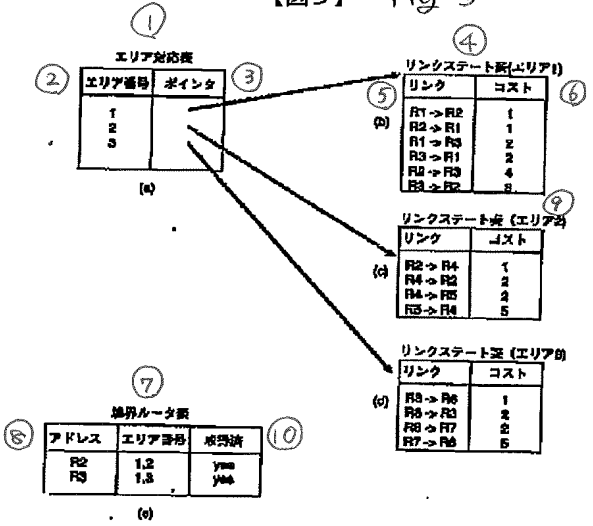


Fig. 2
【図2】

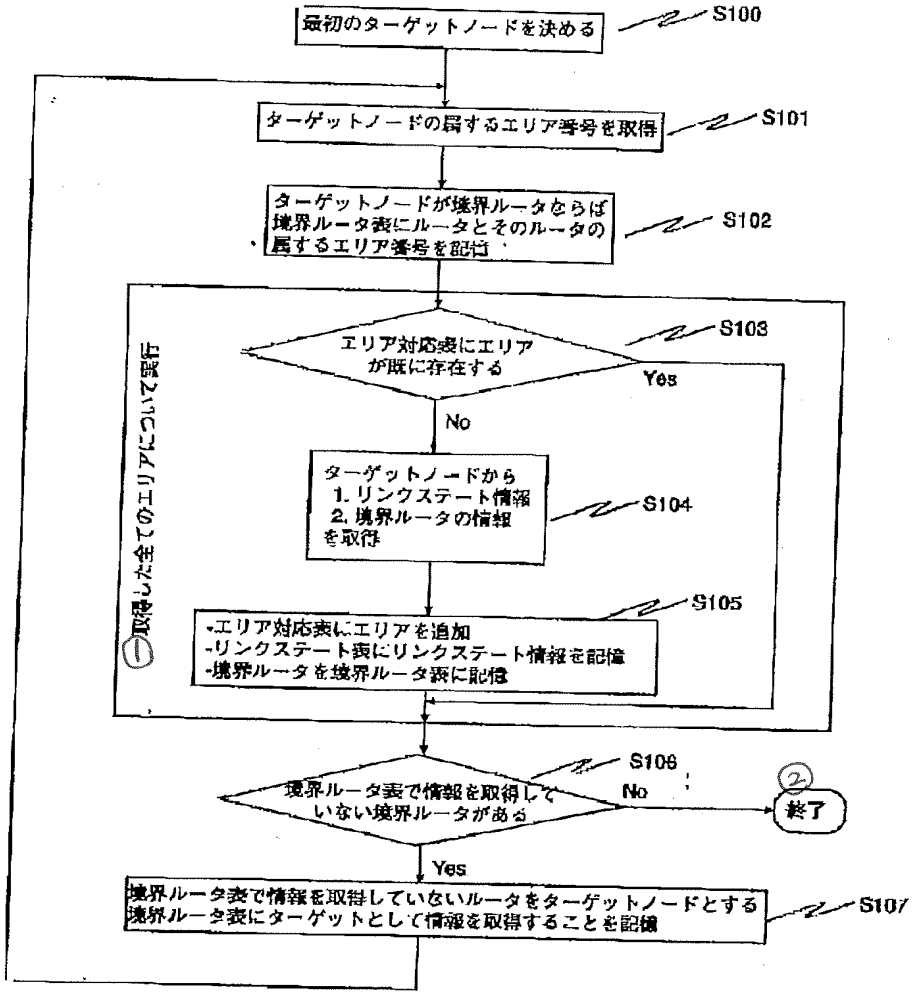
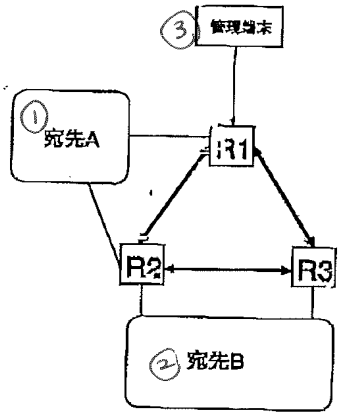


Fig. 5
【図5】



【図4】 Fig. 4

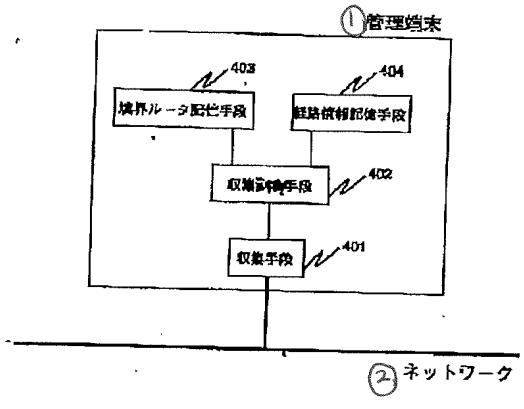


Fig. 7
【図7】

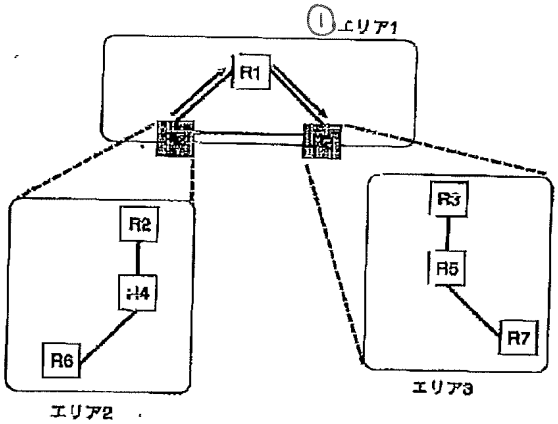
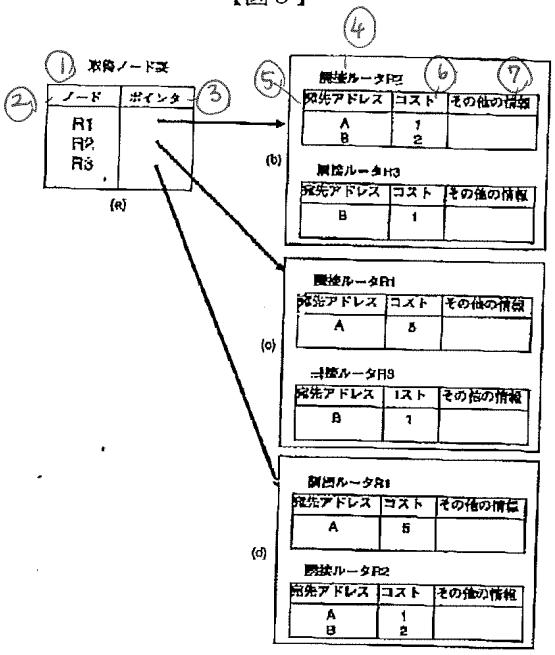


Fig. 6

【図6】


①
次段ノード表
②
ノード
ポインタ
③
R1
R2
R3
(a)
④
⑤
隣接ルータR2
宛先アドレス
コスト
その他の情報
⑥
⑦
A
1
B
2
(b)
隣接ルータR3
宛先アドレス
コスト
その他の情報
B
1
隣接ルータR1
宛先アドレス
コスト
その他の情報
A
5
(c)
隣接ルータR3
宛先アドレス
コスト
その他の情報
B
1
隣接ルータR1
宛先アドレス
コスト
その他の情報
A
5
(d)
隣接ルータR2
宛先アドレス
コスト
その他の情報
A
1
B
2